

BEAM LOSS INDUCED BACKGROUNDS IN BTeV

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BTev IP Review - II

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OUTLINE

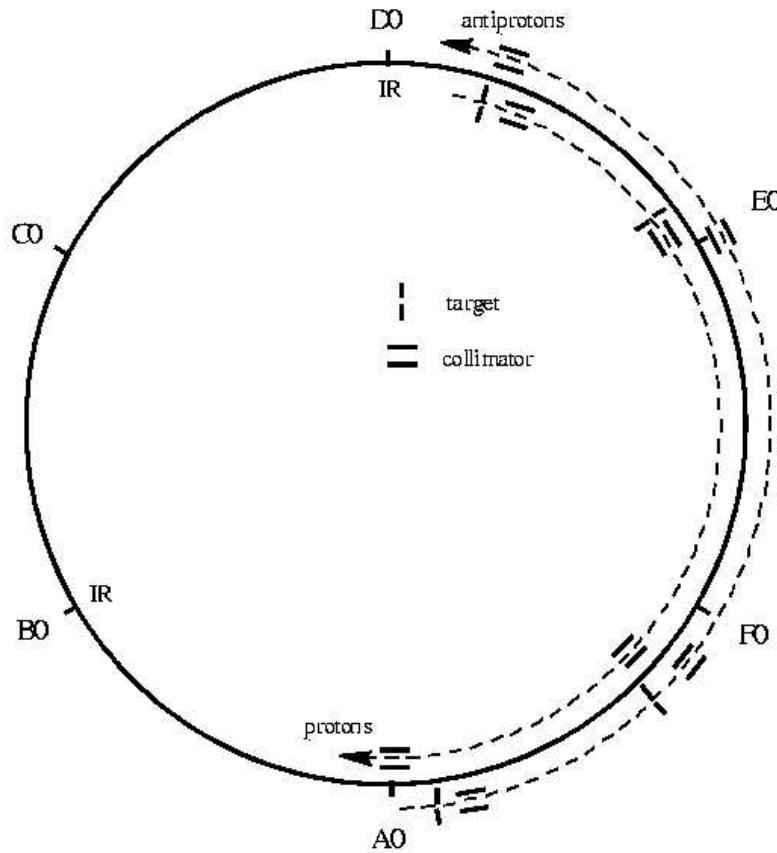
- Source Terms
- Beam Loss Simulations with STRUCT
- MARS14 Modeling of CØ Region
- Particle Flow into BTeV Hall

SOURCE TERMS

1. $p\bar{p}$ collisions at $\mathcal{L}=2\times 10^{32} \text{ cm}^{-2}\text{s}^{-1}$
2. Operational beam loss: beam-gas scattering*.
3. Operational beam loss: tails from collimators*.
4. Accidental beam loss: abort kicker prefire.

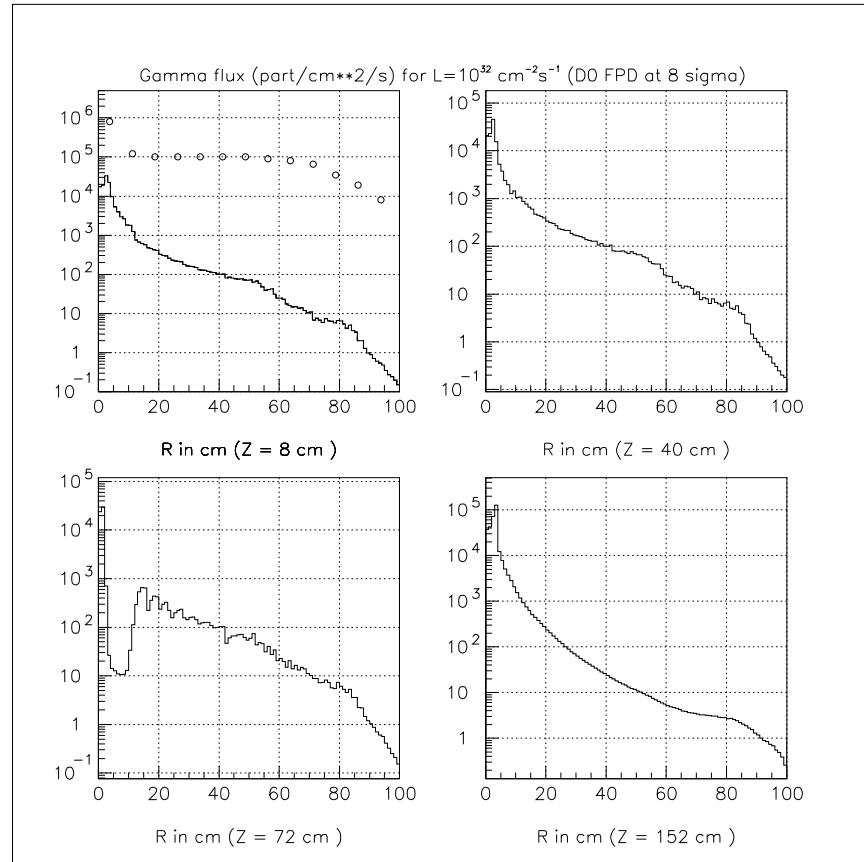
* - subject of this talk.

TEVATRON RUN II COLLIMATION



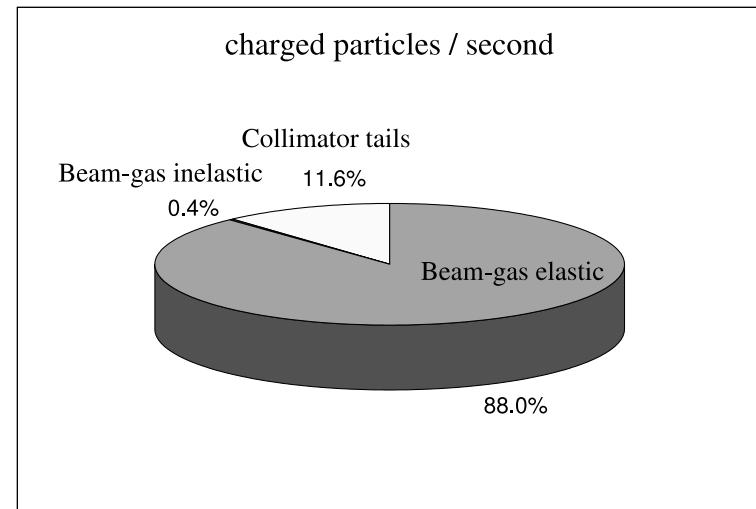
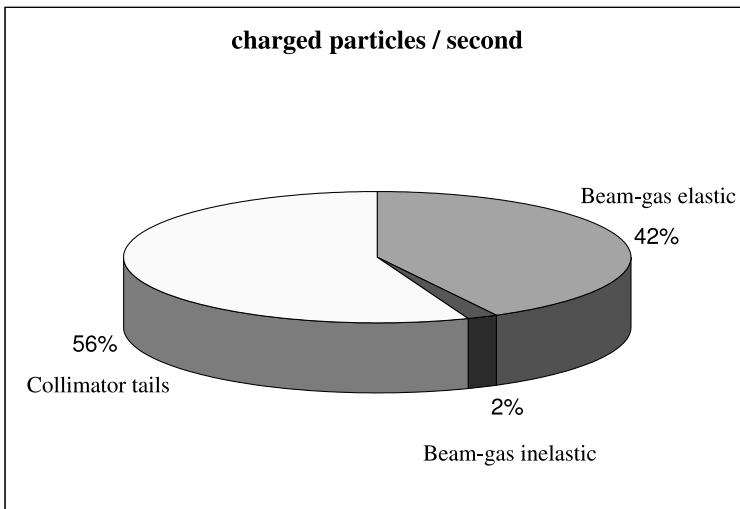
Without CDF and DØ, CØ electrostatic separators and low- β quads are the first limiting apertures for proton beam either **scattered on residual gas** in the AØ – CØ sectors or misbehaved due to the **AØ abort kicker prefire**.

LUMINOSITY vs BEAM LOSS: WHAT TO EXPECT AT CØ



Beam-loss (tails from collimators) induced radial distributions of photon flux in the DØ central detector (with FPD Roman Pots) at four distances from IP in comparison to that due to $p\bar{p}$ collisions (symbols), MARS14 both.

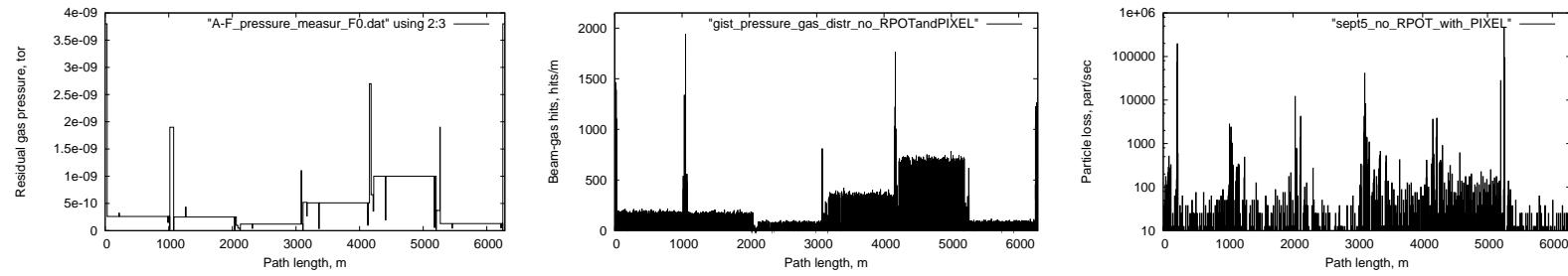
PARTIAL BACKGROUNDS



Partial backgrounds at the CDF West Beam Halo Monitors at average pressure in Tevatron of 10^{-10} (left) and 10^{-9} (right) torr.

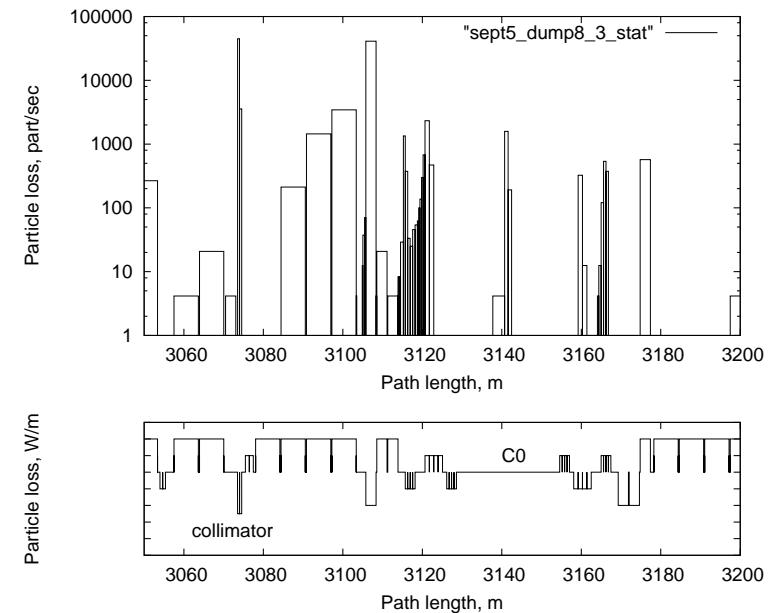
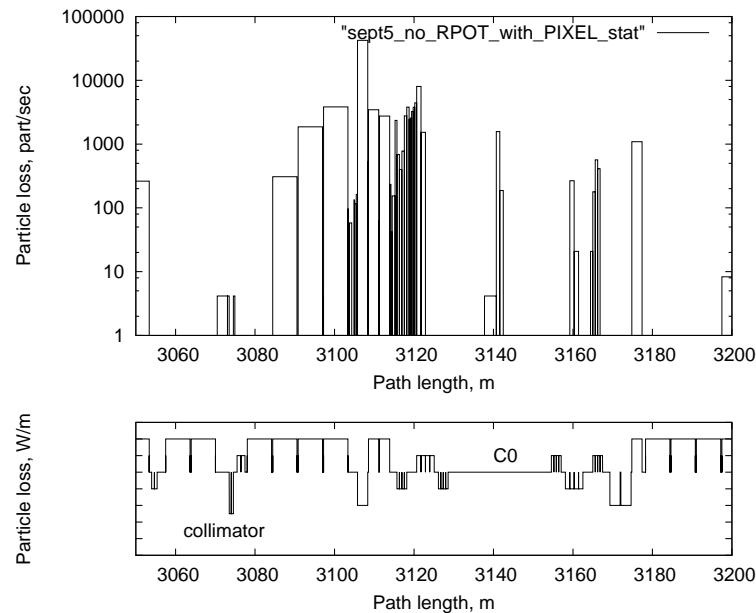
Beam loss in $B\emptyset$ due to beam-gas elastic scattering exceeds that from tails from the main collimators at $\langle P \rangle \geq 2 \times 10^{-10}$ torr.

BEAM-GAS INTERACTIONS



Measured residual gas pressure (left), beam-gas hits (middle) and corresponding beam loss distributions (right).

STRUCT: BEAM LOSS DISTRIBUTIONS IN CØ



Baseline (left) and with B48 collimator (right)

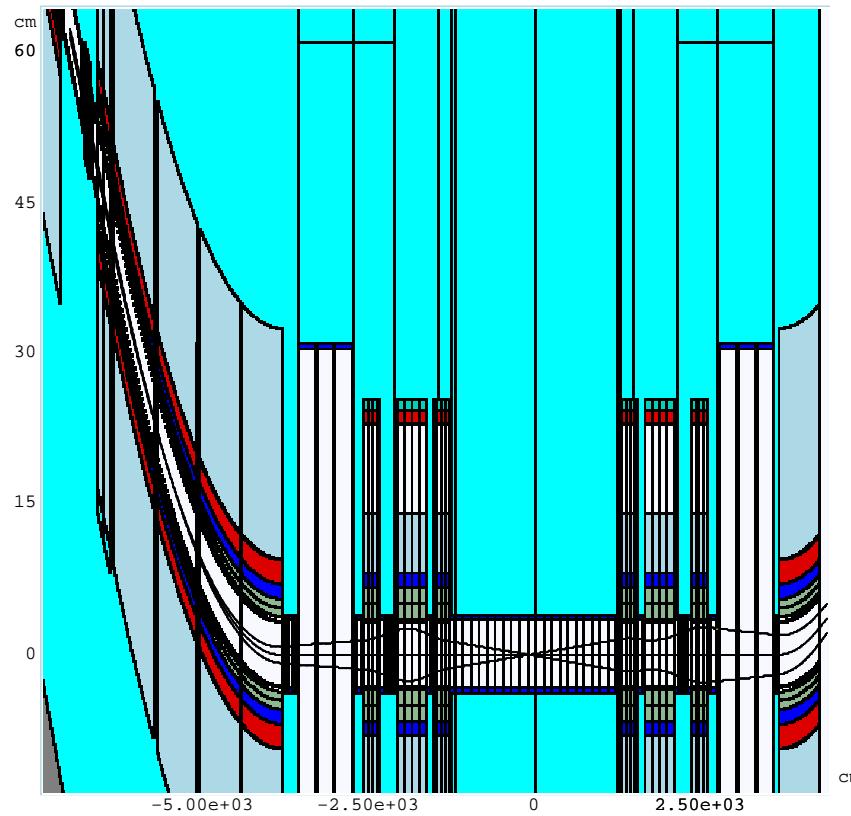
Pixel aperture diameter is 5.5 mm. CØ: $\beta_{x,y} = 0.35 \text{ m}$, BØ: $\beta_{x,y} \simeq 1.7 \text{ m}$, DØ: $\beta_{x,y} \simeq 1.7 \text{ m}$. B48 1-m SS collimator: $\pm 8 \pm 3 \text{ mm} = \pm 13\sigma_x \pm 42\sigma_y$.

BEAM LOSS IN TEVATRON INTERACTION REGIONS

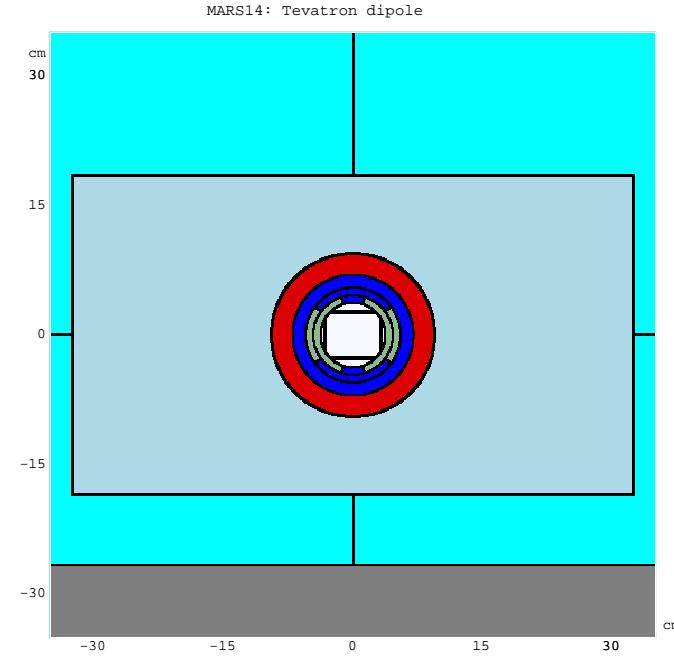
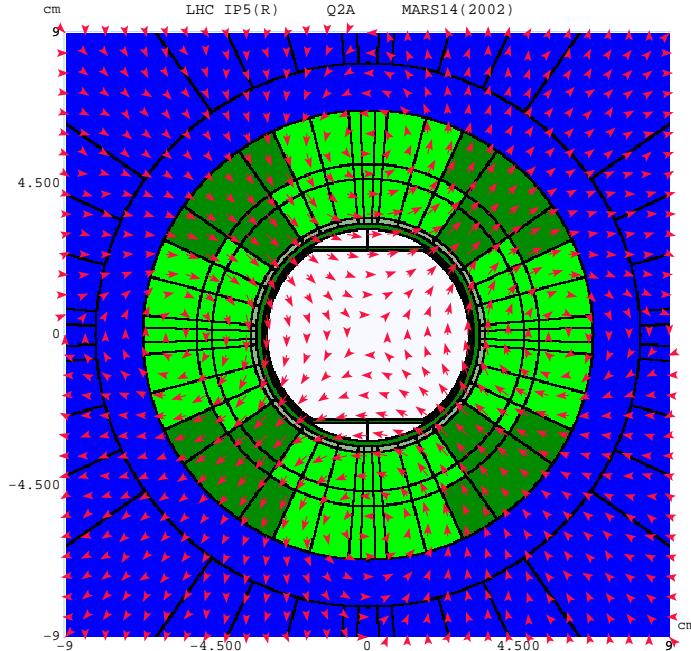
Table 1: Beam loss rates (10^4 s^{-1}) in the 70-m regions upstream of DØ , BØ and CØ (2009) with Run-II vacuum parameters.

Source	DØ	BØ	CØ
Nuclear elastic beam-gas	8.8	8.0	9.4
Large angle Coulomb beam-gas	0.12	0.06	0.1
Tails from collimators	2.4	3.5	0.99
Elastic $p\bar{p}$ at two IPs	0.144	0.105	-

CØ MARS14 MODEL

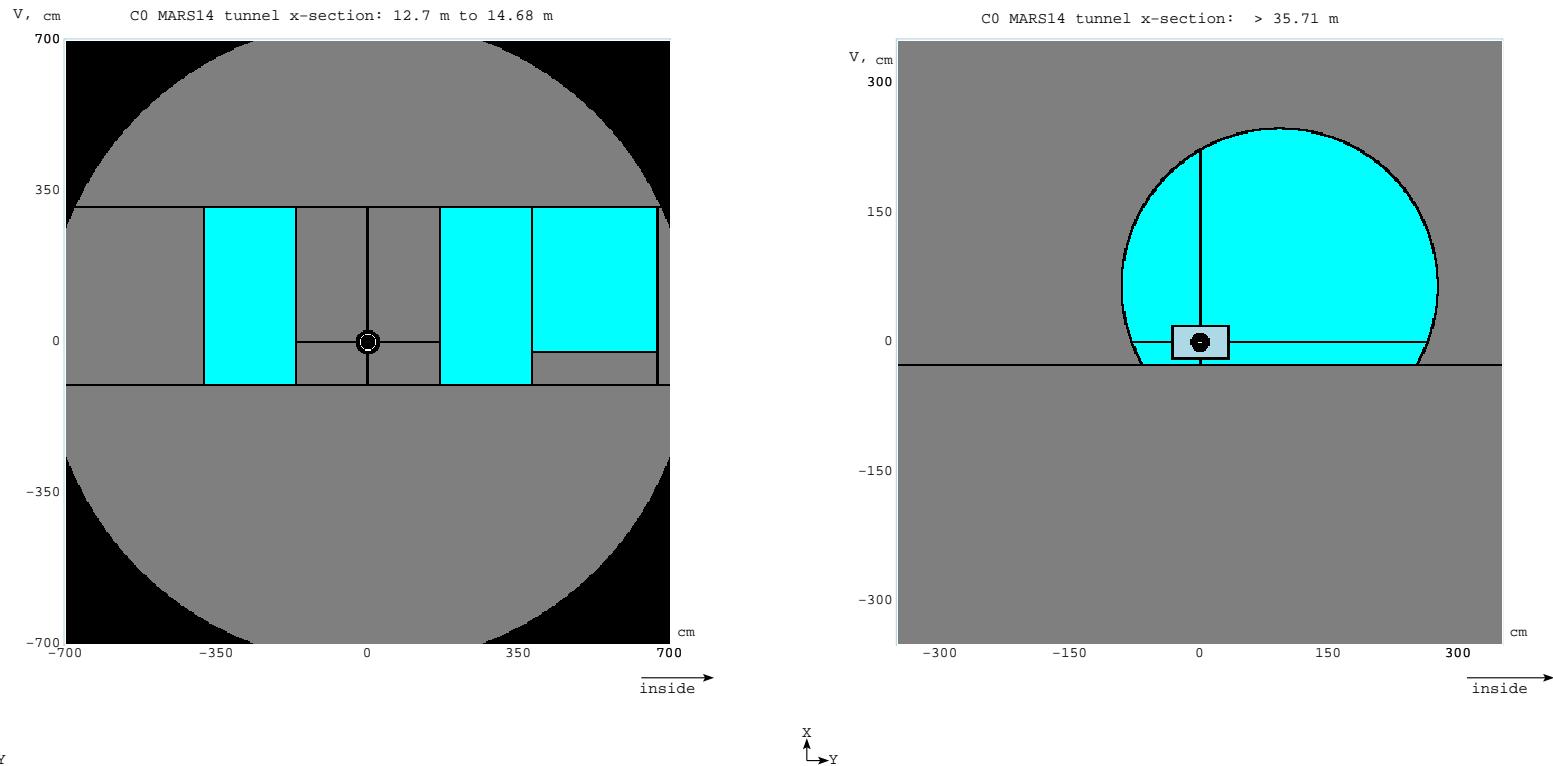


CØ LOW-BETA QUAD AND TEV DIPOLE

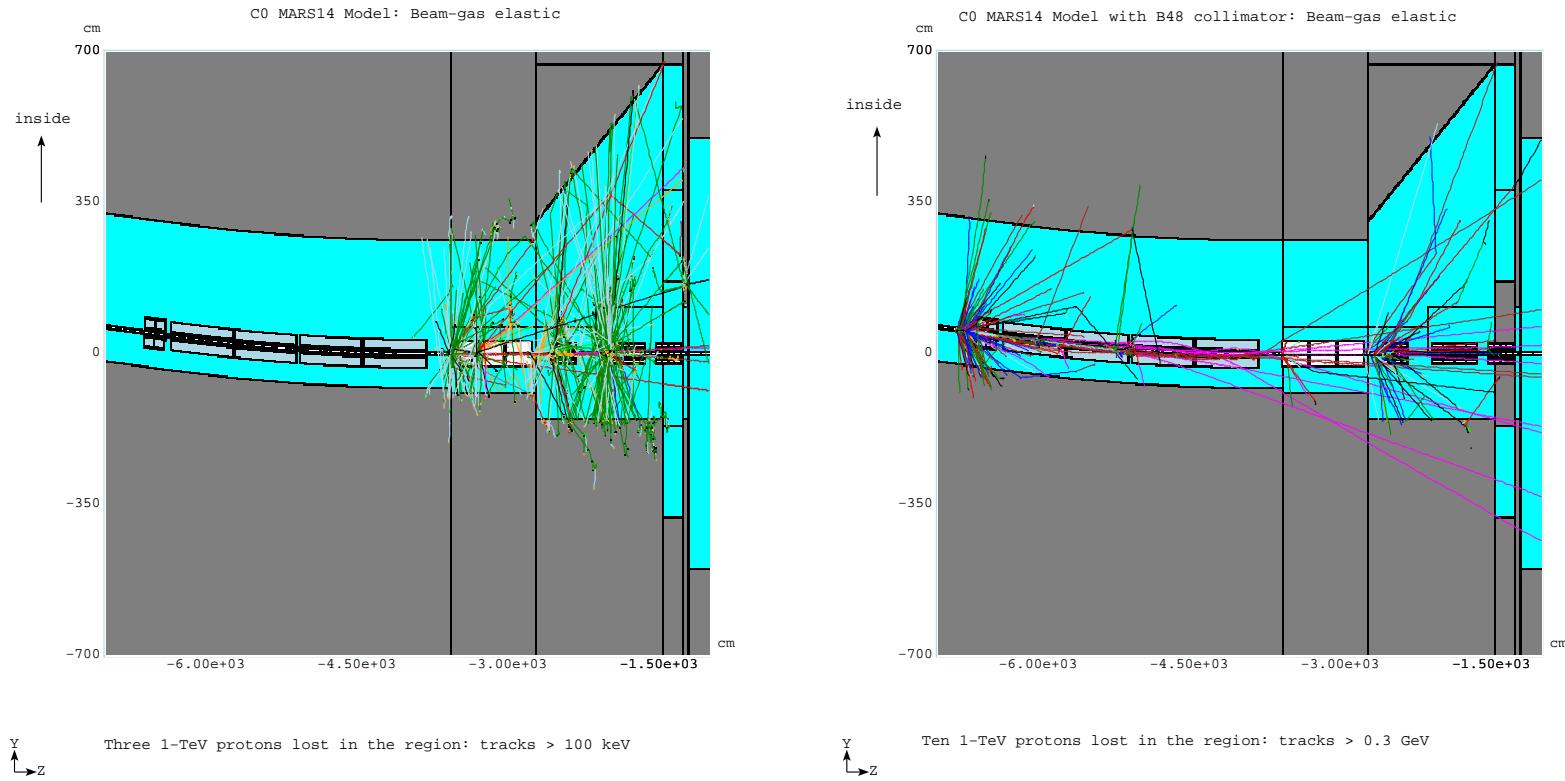


LHC HGQ → CØ low- β quad: beam pipe (ID=63mm, OD=66.5mm), two-layer SC coil (ID=70mm, OD=134mm), collar (OD=162mm), yoke (OD=280mm), cryostat vessel (OD=508mm).

EXAMPLE OF CØ TUNNEL X-SECTIONS

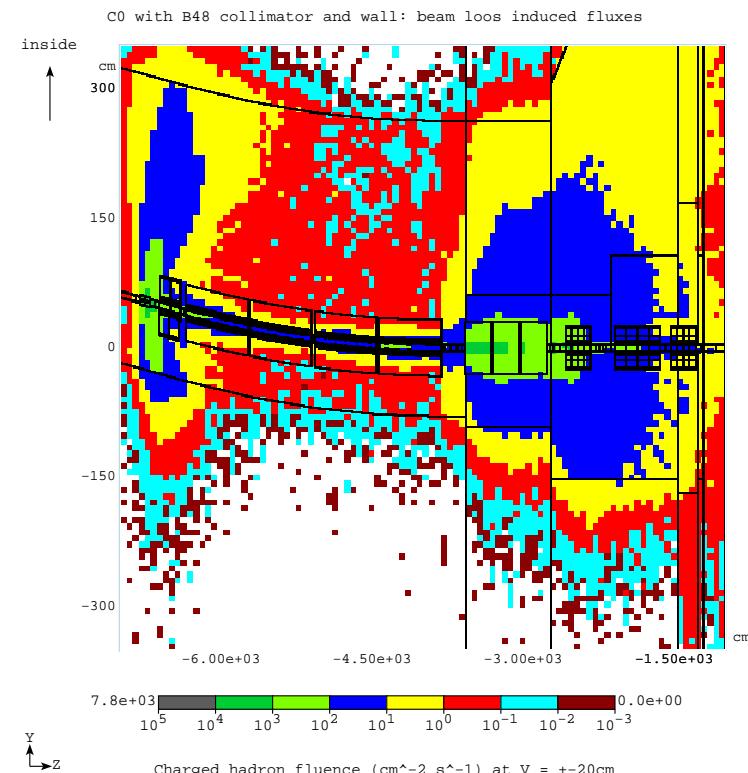
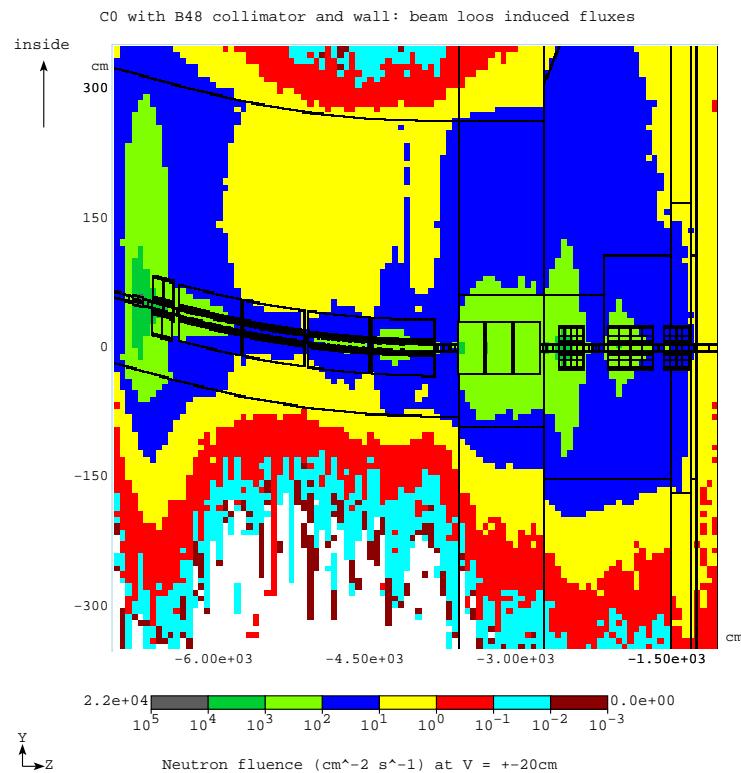


MARS14 BEAM LOSS EVENT SNAPSHOTS



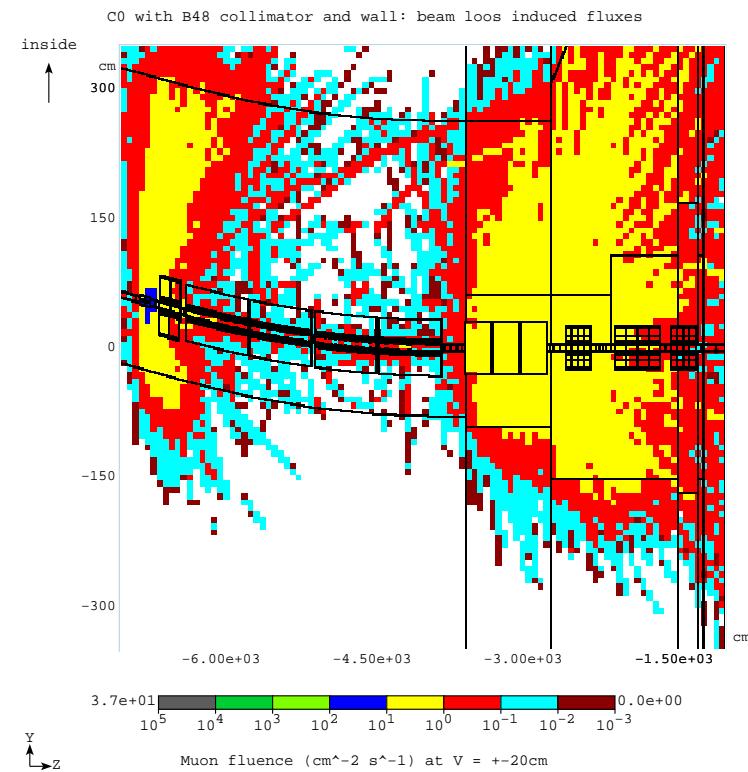
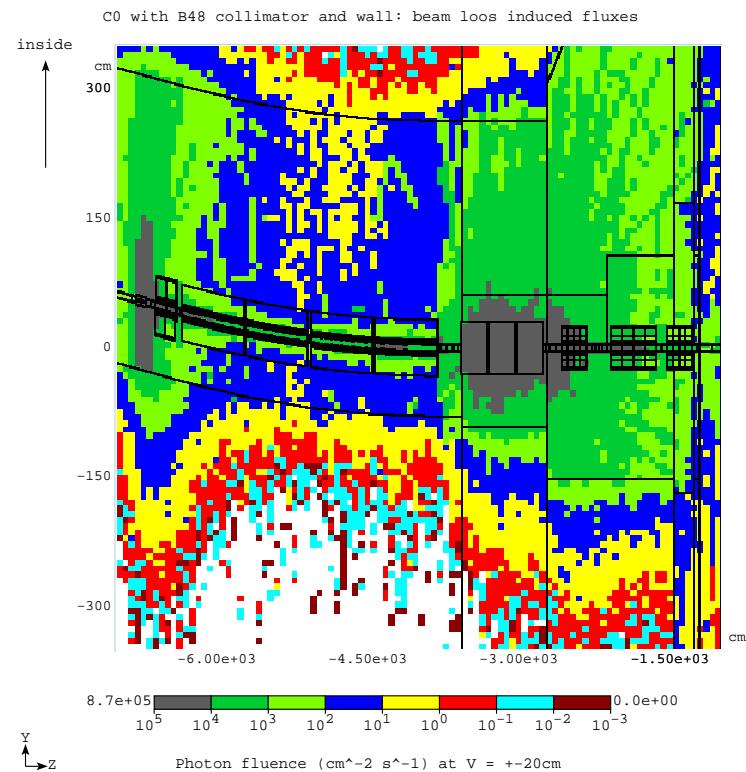
Three 1-TeV protons lost in baseline CØ IR (left) and ten 1-TeV protons lost in CØ IR with 1-m B48 collimator and 2-m concrete shielding wall (right).

NEUTRON AND CHARGED HADRON ISOFLUXES IN CØ IR



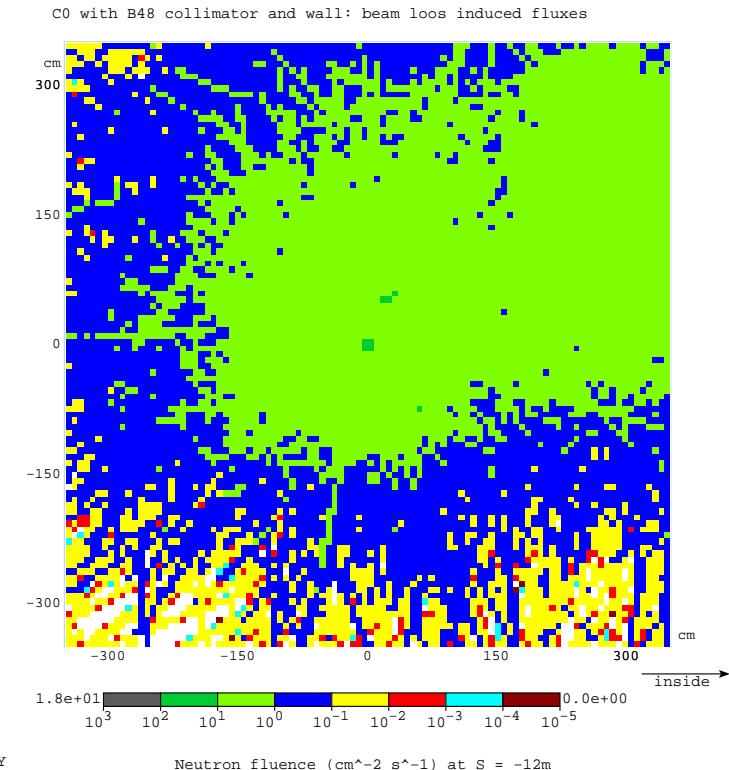
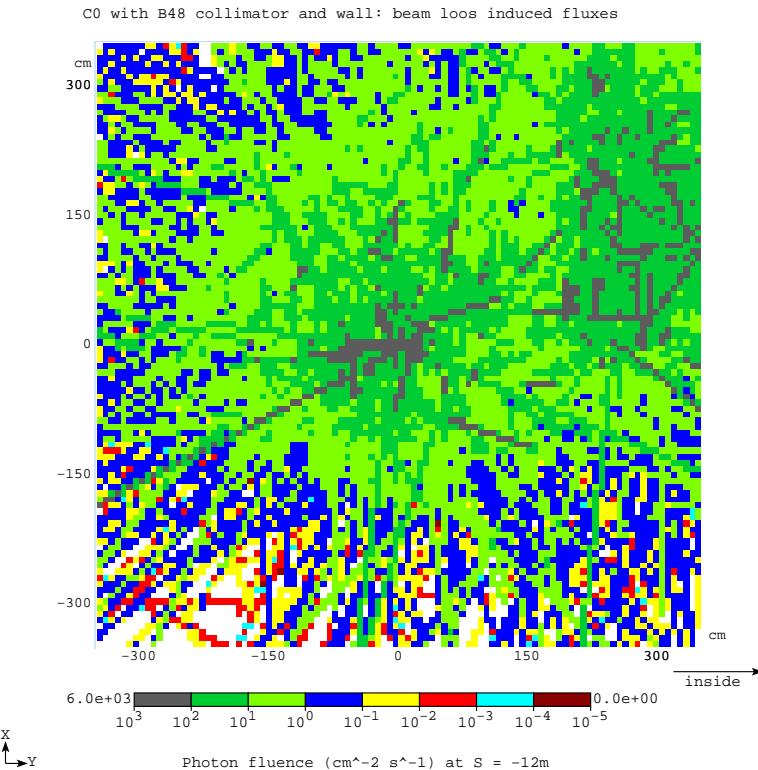
With B48 1-m SS collimator and 2-m concrete shielding wall.

PHOTON AND MUON ISOFLUXES IN CØ IR



With B48 1-m SS collimator and 2-m concrete shielding wall.

PHOTON AND NEUTRON ISOFLUXES ENTERING BTEV HALL

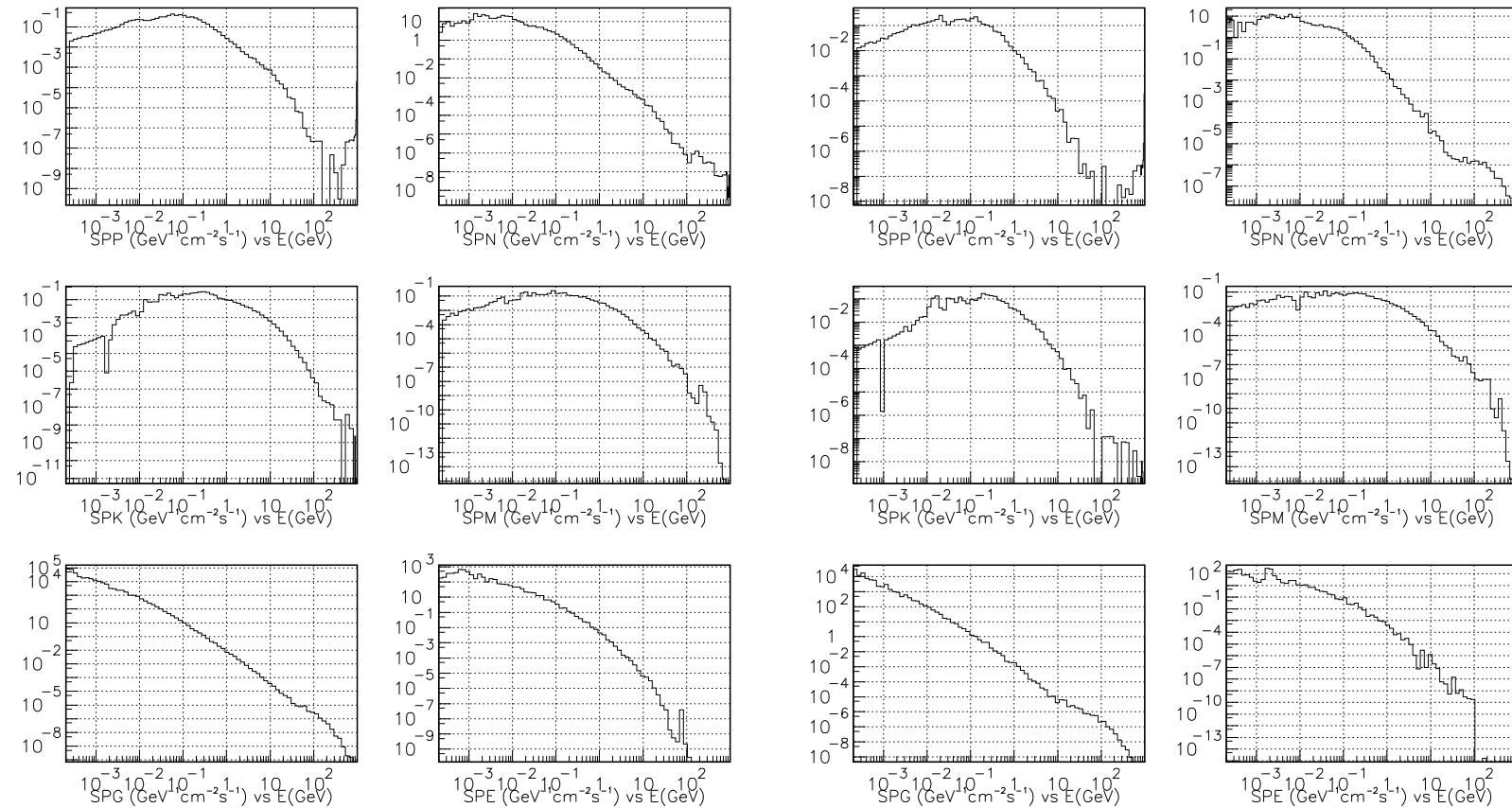


With B48 1-m SS collimator and 2-m concrete shielding wall.

PARTICLE SPECTRA ENTERING BTEV HALL

z4/02/16 14.08

z4/02/16 14.13



Baseline (left) and with B48 1-m SS collimator and 2-m concrete shielding wall (right).

$R < 3.5$ m. SPP - p , SPN - n , SPK - $\pi^\pm + K^\pm$, SPM - μ , SPG - γ , SPN - e^\pm .

PARTICLE FLOW INTO BTeV EXPERIMENTAL HALL

Table 2: Number of particles above 0.1 MeV entering the BTeV hall at $R < 3.5$ m, 10^5 s $^{-1}$

Scenario	n	h^\pm	e^\pm	γ	μ^\pm
No B48, no wall	17.0	11.1	41.7	812	2.17
B48, no wall	7.1	6.1	25.5	431	1.33
B48, 2-m wall	4.4	1.9	4.7	73.7	0.76

Multiply by about 1.1 to account for tails from the TeV collimators.

There is no wall effect at $R < 0.25$ m.

CONCLUSIONS

1. Limit machine-related backgrounds in BTeV at a few percent level of those from $p\bar{p}$ collisions
2. STRUCT model of Tevatron and MARS14 model of CØ IR have been built. Beam loss distributions – induced by beam-gas (dominant) and collimator tails – were calculated and corresponding showers in the CØ IR were modeled, providing files of particles at the entrance to the BTeV hall.
3. About 3×10^6 hadrons and 10^8 photons enter the BTeV hall in a second.
4. A 1-m long SS collimator at B48 reduces these numbers by a factor of two and protects the low- β quads against quench (damage) at normal operation and an abort kicker prefire.
5. A 2-m concrete shielding wall at 12.7 to 14.7 m from the IP further reduces the particle flow into the BTeV hall, with a combined with B48 collimator effect of a factor of 10.
6. Further optimization is possible: additional collimator and shielding wall (configuration and materials).